REMARKS

The Application has been carefully reviewed in light of the Office Action dated November 1, 2002 (Paper No. 12). Claims 6 to 12, 16 to 29, 31 to 32 and 34 have been cancelled without prejudice or disclaims of the subject matter contained therein. Claims 1 to 5, 13 to 15, 30, 33 and 35 are pending in the application, of which Claims 1, 13, 30, 33 and 35 are the independent claims. Claims 1, 2, 13, 30 and 33 have been amended herein. Reconsideration and further examination are respectfully requested.

Initially, Applicants note the indication that the changes requested in the February 19, 2002 Request For Approval To Make Drawing Changes have been approved. Applicants submit herewith a Letter Transmitting Formal Drawings to submit the drawing sheets incorporating these changes.

Claims 1, 4 to 5, 13 to 15, 30, 33 and 35 have been rejected under 35 U.S.C. § 103(a) over JP 11-23324 (Igaki 23324) and U.S. Patent 5,124,548 (Igaki '548) and Claims 2 and 3 have been rejected under 35 U.S.C. § 103(a) over Igaki 23324, Igaki '548 and U.S. Patent 5,483,059 (Igaki '059).

Claims 1 to 5 and 30

The present invention generally concerns an optical system of an optical encoder, the optical system having a dividing element that divides amplitude modulated light traveling from a light irradiating system to an optical scale into beams along a plurality of different directions to guide the beams to respective light-receiving elements. The dividing element comprising a plurality of V-grooves consisting of planes of mutually

different angles juxtaposed at a predetermined pitch to form four beams having different phases.

By virtue of this arrangement, it is possible to obtain a stable signal despite light intensity variations or noise.

Turning to the specific language of the claims, Claim 1 defines an optical encoder comprising a light irradiating system, an optical scale having a grating for transmitting or reflecting incident light, light-receiving elements disposed in a plurality of different directions; and an optical system. The optical system is constructed so as to amplitude-modulate light traveling from the light irradiating system to the optical scale and transmitted or reflected by the grating, by a dividing element in which a plurality of V-shaped grooves are juxtaposed, and so as to divide the amplitude-modulated light into beams along a plurality of different directions to guide the beams to the respective light-receiving elements. The dividing element is comprised of repetitions of such structure that a plurality of V-grooves consisting of planes of mutually different angles are juxtaposed at a predetermined pitch to form four beams having different phases.

The applied art, namely Igaki 23324 and Igaki '548, is not seen t teach or to suggest a dividing element comprised of repetitions of a structure such that a plurality of V-grooves consisting of planes of mutually different angles are juxtaposed at a predetermined pitch to form beams having different phases.

It is stated in the Office Action that Igaki 23324 describes a "trapezoid like" structure which the Office Action indicates teaches using different angles. In addition, at page 8 of the Office Action, it is stated that elements 31b-1 and 31b-2 of drawing 13 of Igaki 23324 consist of different angles. However, as is stated at paragraph [0023] of Igaki

23324, the V-groove sides have an incident angle of 45°. The V-groove sides in Igaki 23324 are therefore not seen to be planes of mutually different angles. In addition, the trapezoid-like structure discussed in paragraph [0012] of Igaki 23324 relates to the shape of the cross-section of the scale formed from two or more V-grooves as can be seen in Drawing 3. In addition, Igaki 23324 is not seen to teach or to suggest V-grooves consisting of planes of mutually different angles juxtaposed at a predetermined pitch to form beams having different phases.

Igaki '548 describes using an angle of slope 45° as seen at col. 4, lines 46 to 52. While Igaki '548 indicates that the angle is not restricted to 45°, Igaki '548 is seen to describe using the same angle, be in 45° or some other angle, and is not seen to suggest using V-grooves consisting of planes of mutually different angles. Further, Igaki '548 is not seen to teach or to suggest V-grooves consisting of planes of mutually different angles juxtaposed at a predetermined pitch to form beams having different phases.

For at least the foregoing reasons, Claim 1 is believed to be allowable over the cited art. In addition, Claim 30 is believed to be allowable for at least the same reasons.

Claims 13 to 15 and 33

The present invention generally concerns an optical scale of an optical encoder, the optical scale with a first and second region each having scale slits comprised of grooves of V-shaped cross section, the slope angles are different from each other between the grooves of the V-shaped cross section of the scale slits so as to form four beams having different phases.

By virtue of this arrangement, it is possible to obtain a stable signal despite light intensity variations or noise.

Turning to the specific language of the claims, Claim 13 defines an optical encoder comprising a light irradiating system, an optical scale comprising scale slits of a periodic structure, a light-receiving element; and an optical system constructed so as to make light traveling from the light irradiating system to the scale slits of a first region of the optical scale, incident to the scale slits of a second region of the optical scale by a mirror or another optical element to guide the light having passed via the scale slits of the second region to the light-receiving element. The optical scale the scale slits of the first and second regions are comprised of grooves of V-shaped cross section and wherein slope angles are different from each other between the grooves of the V-shaped cross section of the scale slits in the first and second regions to form four beams having different phases.

Neither Igaki 23324 nor Igaki '548, either alone or in any permissible combination, is seen to teach or to suggest slope angles different from each other between the grooves of the V-shaped cross section of scale slits in the first and second regions so as to form four beams having different phases.

As discussed above, neither Igaki 23324 nor Igaki '548 is seen to describe using different slope angles, and neither Igaki 23324 nor Igaki '548 is seen to teach or to suggest slope angles different from each other between the grooves of the V-shaped cross section of scale slits in the first and second regions so as to form four beams having different phases.

For at least the foregoing reasons, Claim 13 is believed to be in allowable condition. In addition, Claim 33 is believed to be allowable for at least the same reasons.

Claim 35

The present invention generally relates to a driving system having an optical encoder, which includes an optical system constructed so that light reflected by a first region of an optical scale is condensed via only one condensing mirror onto scale slits of a second region of the optical scale so that the light having passed via the second region's scale slits is guided to a light-receiving element of the optical encoder.

Turning to the specific claim language, Claim 35 defines a driving system comprising a driver system; a control system for controlling driving of the driver system, and an optical encoder for detecting information on the driving of the driver system to output a signal to the control system. The optical encoder comprising a light irradiating system, an optical scale comprising scale slits of a periodic structure, a light-receiving element, and an optical system constructed so that light traveling from the light irradiating system to the scale slits of a first region of the optical scale and reflected by the first region is reflected and condensed via only one condensing mirror onto the scale slits of a second region of the optical scale and so that the light having passed via the scale slits of the second region is guided to the light-receiving element.

Igaki 23324 and Igaki '548, either alone or in any permissible combination, is not seen to teach or to suggest an optical system constructed so that light reflected by a first region of an optical scale is condensed via only one condensing mirror onto the scale slits of a second region of the optical scale so that the light having passed via the scale slits of the second region is guided to the light-receiving element.

The Office Action, at page 5, cites Drawing 14 of Igaki 23324 as showing the above feature. As described by Igaki 23324 with respect to Drawing 14, light from

light source 1 passes through flat surface section 31a of optical scale 31 to mirror 4 and then to an inclined plane 31b of optical scale 31. Drawing 14 is not seen to teach or to suggest light reflected by the first region and condensed via a condensing mirror onto a second region so that light passing the second region is guided to the light-receiving element. Igaki '548 is also not seen to teach or to suggest this feature.

Accordingly and for at least the foregoing reasons, Claim 35 is believed to be in allowable condition.

CONCLUSION

The remaining claims are each dependent from the independent claims discussed above and are therefore believed patentable for the same reasons. Because each dependent claim is also deemed to define an additional aspect of the invention, however, the individual consideration of each on its own merits is respectfully requested.

In view of the foregoing, the entire application is believed to be in condition for allowance, and such action is respectfully requested at the Examiner's earliest convenience.

Applicants' undersigned attorney may be reached in our Costa Mesa, California by telephone at (714) 540-8700. All correspondence should continue to be directed to our address listed below.

Respectfully submitted,

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APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE TO CLAIMS

1. (Amended) An optical encoder comprising:

light irradiating system;

an optical scale having a grating for transmitting or reflecting incident light;

light-receiving elements disposed in a plurality of different directions; and

an optical system constructed so as to amplitude-modulate light traveling from said light irradiating system to said optical scale and transmitted or reflected by the grating, by a dividing element in which a plurality of V-shaped grooves are juxtaposed, and so as to divide the amplitude-modulated light into beams along a plurality of different directions to guide the beams to the respective light-receiving elements;

wherein said dividing element is comprised of repetitions of such structure that a plurality of V-grooves consisting of planes of mutually different angles are juxtaposed at a predetermined pitch to form four beams having different phases.

2. (Amended) The optical encoder according to Claim 1,wherein said four beams form two sets [dividing element forms at least one set] of beams having a phase relation of 180°.

13. (Amended) An optical encoder comprising:

light irradiating system;

an optical scale comprising scale slits of a periodic structure;

a light-receiving element; and

an optical system constructed so as to make light traveling from said light irradiating system to the scale slits of a first region of said optical scale, incident to the scale slits of a second region of said optical scale by a mirror or another optical element to guide the light having passed via the scale slits of the second region to said light-receiving element;

wherein in said optical scale the scale slits of said first and second regions are comprised of grooves of V-shaped cross section and wherein slope angles are different from each other between the grooves of the V-shaped cross section of the scale slits in said first and second regions to form four beams having different phases.

30. (Amended) A driving system comprising:

a driver system;

a control system for controlling driving of said driver system; and

an optical encoder for detecting information on the driving of said driver system to output a signal to said control system, said optical encoder comprising:

(1) light irradiating system;

(2) an optical scale having a grgting for transmitting or reflecting incident light;

(3) separate light-receiving elements disposed in a plurality of different directions; and

(4) an optical system constructed so as to amplitude-modulate light traveling from said light irradiating system to said optical scale and transmitted or reflected by the grating, by a dividing element in which a plurality of V-shaped grooves are juxtaposed, and so as to divide the amplitude-modulated light into beams along a plurality of different directions to guide the beams to the respective separate light-receiving elements;

wherein said dividing element is comprised of repetitions of such structure that a plurality of V-grooves consisting of planes of mutually different angles are juxtaposed at a predetermined pitch to form four beams having different phases.

33. (Amended) A driving system comprising:

a driver system;

a control system for controlling driving of said driver system; and

an optical encoder for detecting information on the driving of said driver system to output a signal to said control system, said optical encoder comprising:

(1) light irradiating system;

(2) an optical scale comprising scale slits of a periodic structure;

(3) a light-receiving element; and

(4) an optical system constructed so as to make light traveling from said light irradiating system to the scale slits of a first region of said optical scale, incident to the scale slits of a second region of said optical scale by a mirror or another optical element to guide the light having passed.,via the scale slits of the second region to said light-receiving element; wherein in said optical scale the scale slits of said first and second regions are comprised of grooves of V-shaped cross section and wherein slope angles are different from each other between the grooves of the V-shaped cross section of the scale slits in said first and second regions to form four beams having different phases.